

National Aeronautics and Space Administration
Goddard Space Flight Center
Contract No. NAS-5-3760

ST - OA - REL - 10 308

NASA TT F-9658

INCLIVITY FORM 801
N65-19706
(ACCESSION NUMBER)
8
(PAGES)
(NASA CR OR TMX OR AD NUMBER)

(THRU)
1
(CODE)
29
(CATEGORY)

DECIMETER BAND RADIOMETER AND MEASUREMENT OF
JUPITER'S PROPER EMISSION

by

O. N. Rzhiga,
G. I. Slobodenyuk,
V. N. Titov,
Z. G. Trunova

[USSR]

GPO PRICE \$ _____

OTS PRICE(S) \$ _____

Hard copy (HC) \$1.00

Microfiche (MF) \$1.50

25 MARCH 1965

DECIMETER BAND RADIOMETER AND MEASUREMENT OF
JUPITER'S PROPER EMISSION

Radiotekhnika i Elektronika
Tom 10, No. 2, 364 - 367,
Izdatel'stvo "NAUKA", 1965

by O. N. Rzhiga,
G. I. Slobodenyuk,
V. N. Titov,
Z. G. Trunova

SUMMARY

19706
This paper deals with the observations of Jupiter's proper emission intensity in the frequency of about 700 Mc/s in October 1963. The modulation radiometer, used to that effect, is described.

The results of these observations corroborate the law of Jupiter's proper emission intensity variation with wavelength, corresponding to measurements by other observers in shorter and longer wavelengths.

* * *

AUTHOR ↑

We conducted in October 1963 the measurement of Jupiter's proper emission intensity in the frequency of ~ 700 mc/sec., using for measurements a modulation radiometer, of which the block-diagram is presented in Fig. 1.

The radiometer's antenna system consists of two identical antennas (A_1 , A_2), oriented in the same direction. Both antenna feeders are connected by means of a double T-branch (TB) [1], whose outputs are alternately switched to receiver (R) with the help of a transfer switch (TS). Follow at receiver output behind the quadratic detector, a modulation frequency amplifier (MFA), a synchronous detector (SD) with an integrating circuit, a d.c. amplifier and a registering device (RD).

At double T-branch output, the oscillations of both antennas are compounded in phase at point a, and in counterphase at point b.

* РАДИОМЕТР ДЕЦИМЕТРОВОГО ДИАПАЗОНА И ИЗМЕРЕНИЕ СОБСТВЕННОГО ИЗЛУЧЕНИЯ ЮПИТЕРА.

The variation of current at radiometer output during passage of a point source with constant velocity through the radiation pattern in the plane of antennas A_1 and A_2 electrical axes, repeats in its form the difference between the "overall" and "differential" radiation patterns of the antenna system, taken at outputs of the double T-branch respectively at points a and b.

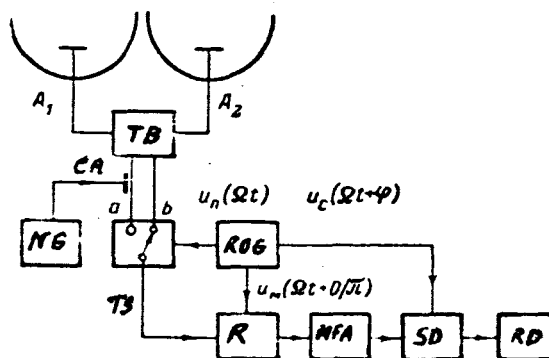


Fig. 1.- Block-diagram of the radiometer:

A_1 , A_2 - antennas; TB - double T-branch; TS - antenna transfer switch; R - superheterodyne receiver with quadratic detector; MFA - modulation frequency amplifier; SD - synchr. detector; RD - registering device; ROG - rectangular oscillation generator; NG - noise generator; CA - capacitance attenuator.

A coaxial line transfer switch was worked out on parametric semiconductor diodes for alternate switching of receiver to points a and b of the double T-branch [2].

The incomplete identity of electrical characteristics of the double T-branch's channels may induce a parasitic signal impairing the sensitivity of the radiometer. In order to eliminate the parasitic signal on the grid of one of amplifier tubes of intermediate frequency, a modulated voltage u_m of rectangular form, fed from the generator ROG (Fig. 1), whose polarity either coincides or is opposite to u_m voltage, arrives to transfer switch. Prior to measurements, the polarity and the amplitude of modulating voltage are so chosen, that the variation of MFA's amplification factor, caused by periodical shift of the operating point of tube's characteristic, smooth off the signal level difference at detector output in both positions of the transfer switch TS.

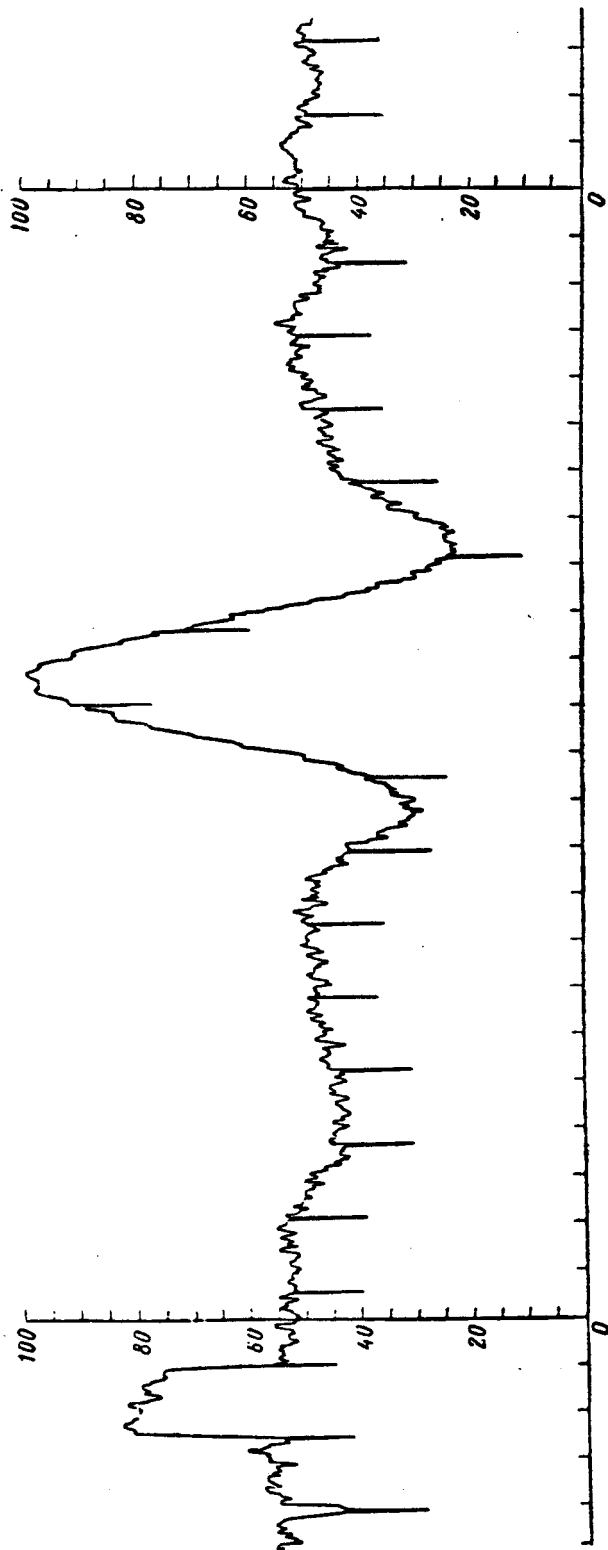


Fig. 2. - Curve of source's Virgo A passage, obtained with a time constant of 2 seconds; the calibration signal is on the left.

Calibration
signal

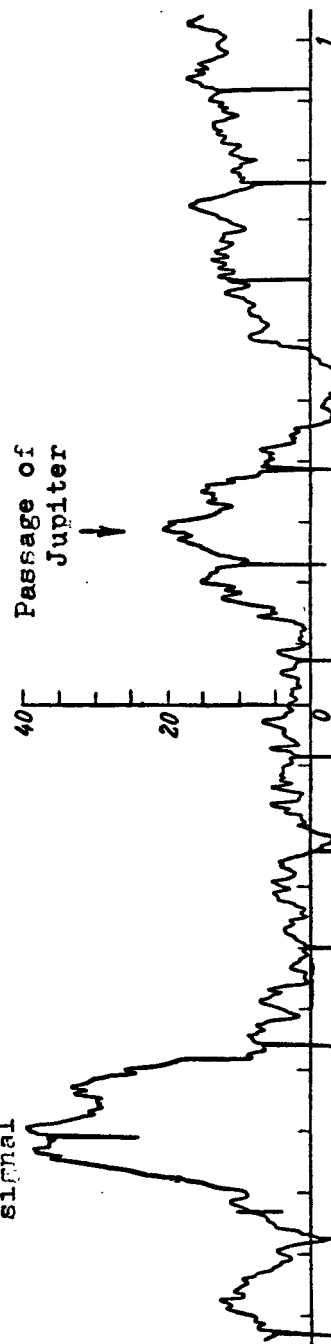


Fig. 3. - Curve of Jupiter's passage obtained with a time constant of 15 seconds.

The modulation frequency is chosen sufficiently high — 525 cps so as to exclude the effects of fluctuations of receiving circuit amplification, and not multiple of 50 cps, so as to rid ourselves of interferences from the harmonics of the feeding grid. The MFA has a pass-band of 10 cps.

The synchronous detector (SD) is assembled according to a ring circuit on semiconductor silica diodes $\Delta 101A$. The time constant of the integrating RC-filter at its output was chosen equal to 1, 2, 5, 10 or 15 seconds.

The rectangular oscillation generator (ROG) consists of quartz-stabilized generator to a frequency of 1050 cps, from which short pulses setting on a trigger cell, are formed by means of limitation and differentiation. At trigger output there is obtained a rectangular oscillation with recurrence frequency $F = 525$ cps. This rectangular oscillation is fed to the transfer switch u_n for the IFA modulation (intermediate frequency amplifier modulation) — u_M and to the synchronous detector u_c . The oscillation, fed to the synchronous detector, is preliminarily shifted in phase by an angle φ for the compensation of signal lag in the narrow-band circuit of the MFA.

A noise generator (NG) is utilized for the calibration of the radiometer.

The fluctuation sensitivity of the radiometer with a 15 sec time constant of the integrating circuit constituted $0.4^\circ K$.

When observing the sources the radiometer antenna was set with a $1 - 2^\circ$ advance by azimuth. Tracking was conducted only by the angle of the spot. The passage of the discrete source Virgo A (M-87) through the antenna system's radiation pattern is plotted in Fig. 2. A standard noise signal, serving for the calibration of the radiometer, is shown on registrations. Minute annotations seen on registrations, were given for tying the time. A typical curve of single Jupiter passage is plotted in Fig. 3.

The determination of the intensity of received emission from Jupiter was conducted by the standard noise signal, calibrated with the

aid of the source Virgo A. The density of this source's emission flux in the frequency of 960 mc/s constitutes $300 \cdot 10^{-26} \text{ w m}^{-2} \text{ cps}^{-1}$, while the spectral index is -0.72 [3]. Using these data we computed the density of this source's emission flux for the frequency, at which measurements were conducted.

For the computation of the equivalent temperature of Jupiter we applied the expression

$$T_{\pi} = \frac{S_{\pi} \lambda_0^2 P_{\pi}}{2k\Omega_{\pi} P_{\pi}}, \quad (1)$$

where S_{π} is the density of the radio emission of Virgo A in the wavelength λ_0 ; P_{π} and P_{π} are respectively the powers of Jupiter and Virgo A emissions in the band Δf , reduced to receiver input; the ratio P_{π}/P_{π} is determined from observations; k is the Boltzmann constant; Ω_{π} is the solid angle of the planet.

The expression (1) was obtained with the help of the following correlations:

$$P_{\pi} = \frac{1}{2} S_{\pi} A_{\pi} \Delta f = \frac{S_{\pi} \lambda_0^2 \Delta f}{2\Omega_{\pi}}, \quad (2)$$

$$P_{\pi} = kT_{\pi} \Delta f \frac{\Omega_{\pi}}{\Omega_{\pi}}, \quad (3)$$

where A_{π} is the effective area of the antenna; Δf is the radiometer band to the detector; Ω_{π} is the solid angle of the ray of antenna system's radiation pattern.

The value of the mean Jupiter's equivalent temperature, obtained from a series of observations, constituted $12\,000^{\circ} \text{K}$ (upon conversion to visible dimensions of the planet) with a root-mean-square error of 2000°K . In this value of the error the inaccurate knowledge of the orientation of antenna's polarization ellipses and Jupiter emission and the lack of precision in the determination of Virgo A flux density (4%) is taken into account [4].

The results of observations, expounded in the given paper, corroborate the law of Jupiter emission intensity variation with wavelength (see Fig. 4, next page), corresponding to measurements by other observers

in shorter or longer wavelengths, refer to [5 — 12].

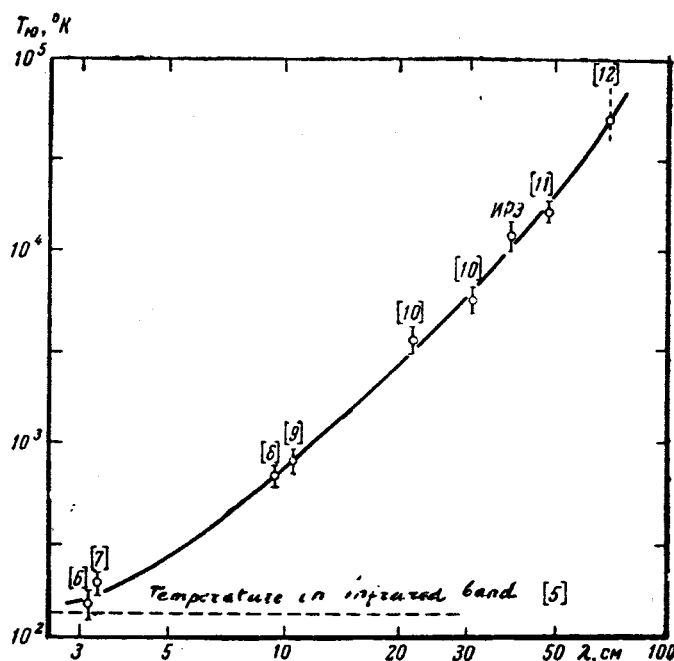


Fig. 4. - Variation of the mean equivalent temperature of Jupiter with wavelength according to observations by various authors, including those of the present paper.

The authors express their gratitude to R. A. Andreyev, M. M. Dedlovskiy, A. S. Denisov and V. F. Chernov, having participated in the preparation and conducting of measurements.

**** THE END ****

Institute of Radio Engineering
and Electronics of the USSR
Academy of Sciences

Received on 24 February 1964

Contract No. N AS-5-3760
Consultants & Designers, Inc.
Arlington, Virginia

Translated by ANDRE L. BRICHANT
on 26 March 1965

REFERENCES

- [1].- F. TISHER.- Tekhnika izmereniy na sverkhvysokikh chastotakh.
(Techniques of measurements at ultrahigh frequencies).
GIFML., 1963
- [2].- G. I. SLOBODENYUK.- Pribory i tekhnika eksperimenta, 2, 111, 1964.
(Devices and experiment techniques).-
- [3].- D. E. HARRIS, J. A. ROBERTS.- Publ. Astr. Soc. Pacific, 72, 237, 1962.
- [4].- G. R. WHITFIELD, Monthly Notices Roy Astron. Soc., 117, 680, 1957.
- [5].- D. H. MENZEL, W. W. COBLENTZ, C. O. LAMPLAND.- Astroph. J., 63, 117, 1962.
- [6].- C. H. MAYER, T. P. McCULLOUGH, R. M. SLOANAKER.- Ibid. 127, 11, 1958.
- [7].- J. A. GIORDMAINE, L. E. ALSOP, C. H. TOWNES, C. H. MAYER. Astronom. J. 64,
332, 1959
- [8].- W. K. ROSE, J. M. BOLOGNA, R. M. SLOANAKER, Ibid. 68, 78, 1963.
- [9].- D. MORRIS, J. F. BARTLET, Mém. Soc. Roy. Sci. Liège, 7, 564, 1963.
- [10].- D. MORRIS, G. L. BERGE., Astrophys. J. 136, 276, 1962.
- [11].- D. BARBER, D. L. MOULE., Nature, 198, 947, 1963.
- [12].- F. D. DRAKE, S. HVATUM.- Astronom. J. 64, 329, 1959.

DISTRIBUTION

<u>GODDARD SPACE F.C.</u>		<u>NASA HQS</u>		<u>OTHER CENTERS</u>
600	TOWNSEND	SS	NEWELL, CLARK	<u>AMES R. C.</u>
	STROUD	SG	NAUGLE	SONETT [5]
610	MEREDITH		SCHARDT	LIB. [3]
611	McDONALD		ROMAN	<u>LANGLEY r</u>
	ABRAHAM		SMITH	160 ADAMSON
	BOLDT		DUBIN	185 WEATHERWAX [2]
612	HEPPNER	SL	LIDDEL [3]	235 SEATON
	NESS		BRUNK	JONES
613	KUPPERIAN [3]		FELLOWS	<u>JPL</u>
614	LINDSAY		HIPSHER	
	WHITE		HOROWITZ	
615	BOURDEAU	SM	FOSTER	NEWBURN [3]
	BAUER		ALLENBY	KAPLAN
640	HESS [3]		GILL	LIBRARY
	O'KEEFE		BADGLEY	
641	BURLEY, W. CAMERON	RR	KURZWEG	<u>UCLA</u>
660	GI for SS [5]	RED	SULLIVAN	COLEMAN
252	LIBRARY [3]	REI	VACCA	<u>NO</u>
256	FREAS		MENZEL	LIBRARY
		RTR	NEILL	
		ATSS	SCHWIND [5]	
		WX	SWEET	